

IN THE CLAIMS

1. A process for purifying a contaminated gas stream by conversion of the contaminants into less harmful products, comprising the steps of:

(a) providing a photocatalytic stage having a photocatalyst and a source of UV radiation;

(b) providing a catalytic stage downstream of said photocatalytic stage, said catalytic stage having a catalyst;

(c) passing said contaminated gas stream through said photocatalytic stage by contacting said gas stream with said photocatalyst while irradiating said contaminated gas stream and photocatalyst with UV radiation so as to oxidize at least a portion of said contaminants to an oxidized species;

(d) removing said gas stream with said oxidized species of contaminants from said photocatalytic stage; and

(e) passing said gas stream with oxidized species of contaminants through said catalytic stage by passing said stream over said catalyst at elevated temperatures so as to further convert said oxidized species and remaining contaminants to less harmful products.

2. A process according to claim 1, further including the steps of repeating steps (c) through (e) a plurality of times.

3. A process according to claim 1, further including providing a plurality of alternating photocatalytic and catalytic stages in series.

4. A process according to claim 1, wherein said gas stream in said photocatalytic stage is irradiated with ultraviolet light having a wave length of about 150 to about 400 nanometers.

5. A process according to claim 4, wherein said wavelength is between about 250 to about 375 nanometers.

6. A process according to claim 4, wherein said contaminated gas stream has a residence time in said photocatalytic stage of between about .001 to about 5 seconds, where the residence time is defined as the ratio of the volume of the photocatalyst to the total volumetric flow rate of said contaminated gas stream.

7. A process according to claim 4, wherein said contaminated gas stream has a residence time in said photocatalytic stage of between about 0.01 to about 2 seconds, where the residence time is defined as the ratio of the volume of the photocatalyst to the total volumetric flow rate of said contaminated gas stream.

8. A process according to claim 6, wherein the process is carried out in the photocatalytic stage under the following conditions: a temperature of between about 20°F to about 1200°F; a pressure of between about 0.2 atm to about 10 atm.

9. A process according to claim 6, wherein the process is carried out in the photocatalytic stage under the following conditions: a temperature of between about 50°F to about 1000°F; a pressure of between about 0.8 atm to about 1.5 atm.

10. A process according to claim 6, wherein the process is carried out in the photocatalytic stage under the following conditions: a temperature of between about 100°F to about 800°F; a pressure of between about 0.8 atm to about 1.5 atm.

11. A process according to claim 1, wherein said photocatalyst is selected from the group consisting of:

(a) from about 0.01 to about 8.0 wt.% titania, from about 0.01 to about 8.0 wt.% zirconia, and balance essentially silica;

(b) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, balance essentially silica;

(c) from about 0.01 to about 8.0 wt.% titania, from about 0.01 to about 8.0 wt.% zirconia, and an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, balance essentially silica;

(d) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, and balance essentially titania;

(e) an element selected from the group consisting of gold, silver and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, and balance essentially titania; and

(f) from about 10.0 to about 50.0 wt.% tungsten oxide, from about 0.1 to about 70.0 wt.% silica, from about 30.0 to about 90.0 wt.% titania, and an element selected from the

group consisting platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%.

12. A process according to claim 1, wherein said photocatalyst comprises titania and an element selected from the group consisting of platinum, palladium and mixtures thereof.

13. A process according to claim 1, wherein said photocatalyst comprises from about 0.1 wt.% to about 70 wt.% silica, from about 30 wt.% to about 90 wt.% titania, and from about 10 wt.% to about 50 wt.% tungsten oxide.

14. A process according to claim 13, wherein said tungsten oxide is present in an amount of between about 20 wt.% to about 30 wt.%.

15. A process according to claim 13, wherein said photocatalyst further includes an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 wt.% to about 50 wt.%.

16. A process according to claim 6, wherein said gas stream with said partially oxidized species of contaminants

has a residence time in said catalytic stage of between about .001 to about 5 seconds, where the residence time is defined as the ratio of the volume of the catalyst to the total volumetric flow rate of said stream.

17. A process according to claim 7, wherein said gas stream with said partially oxidized species of contaminants has a residence time in said catalytic stage of between about .01 to about 5 seconds, where the residence time is defined as the ratio of the volume of the catalyst to the total volumetric flow rate of said stream.

18. A process according to claim 16, wherein the process is carried out in the catalytic stage under the following conditions: a temperature of between about 200°F to about 1200°F; a pressure of between about 0.2 atm to about 10 atm.

19. A process according to claim 17, wherein the process is carried out in the catalytic stage under the following conditions: a temperature of between about 300°F to about 1000°F; a pressure of between about 0.8 atm to about 1.5 atm.

20. A process according to claim 1 wherein said catalyst is selected from the group consisting of:

(a) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, and balance essentially a component selected from the group consisting of alumina, silica and mixtures thereof

(b) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, and balance essentially titania;

(c) from about 10.0 to about 50.0 wt.% tungsten oxide, from about 0.1 to about 70.0 wt.% silica, from about 30.0 to about 90.0 wt.% titania, and an element selected from the group consisting platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%; and

(d) from about 25 to about 90 wt.% manganese oxide, from about 0.5 to about 40 wt.% copper oxide and from about 0.5 to about 40 wt.% alumina.

21. A process according to claim 1, wherein said catalyst comprises from about 0.1 wt.% to about 70 wt.% silica, from about 30 wt.% to about 90 wt.% titania, and from about 10 wt.% to about 50 wt.% tungsten oxide.

22. A process according to claim 21, wherein said tungsten oxide is present in an amount of between about 20 wt.% to about 30 wt.%.

23. A process according to claim 22, wherein said catalyst further includes an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 wt.% to about 50 wt.%.

24. A process according to claim 1, wherein said contaminated gas stream contains halogen atoms and said catalyst is selected from the group consisting of:

(a) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, and balance essentially titania;

(b) an element selected from the group consisting of platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt.%, balance essentially silica;

(c) from about 10.0 to about 50.0 wt.% tungsten oxide, from about 0.1 to about 70.0 wt.% silica, from about 30.0 to about 90.0 wt.% titania, and an element selected from the

group consisting platinum, palladium and mixtures thereof in an amount of between about 0.01 to about 5.0 wt. %.

25. An apparatus for purifying a contaminated gas stream comprising:

- (a) a first stage photocatalytic reaction zone having a source of ultraviolet light and a photocatalyst;
- (b) a second stage catalytic reaction zone downstream of said first stage, said second stage having a catalyst; and
- (c) means for feeding the gas stream serially through said first stage and said second stage.

26. An apparatus according to claim 25, including a plurality of alternating photocatalytic and catalyst stages in series.

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